Planting

The key to a seedling's survival after planting is the ability of the root system to quickly begin taking up water and nutrients. Newly planted seedlings cannot get moisture from dry soils. Delay planting under these conditions until sufficient rainfall occurs to recharge soil moisture. If the soil is flooded, and drainage does not occur until late March or April, plant container seedlings when conditions become favorable. The container seedlings can be stored in the shade for several weeks if necessary. They must be handled carefully and watered as conditions require.

The decision to continue or postpone planting when planting conditions deteriorate is a difficult one. It is expensive to let a planting crew play cards because the temperature has increased or decreased beyond acceptable limits. It is doubly expensive however to plant seedlings under conditions that guarantee failure. In this case, not only the cost of planting is lost, and the cost of the seedlings is lost, but also site preparation may need to be repeated the following year.

A common situation in the South occurs at the end of the planting season in March or early April. The air temperature and windspeed increases during the day, and the relative humidity drops drastically. This is our traditionally high-risk fire weather. Should planting continue or be postponed?

High-quality seedlings are essential for a successful plantation.

Depending on the site, either hand or machine planting can be the most efficient and reliable option. Large, level, open tracts are most efficiently planted by machine, while smaller or irregularly shaped tracts, sites with minimal site preparation, and rocky sites are more easily hand-planted.

Show planters the correct depth to plant seedlings. The proper depth varies with soil and site conditions, but seedlings should be no deeper than the length of the dibble bar or the foot on the planting machine. Shallow planting results in early seedling mortality, particularly during early spring and summer droughts. On many old-field sites, the soil contains a compacted plow-pan that must be broken by subsoiling to permit deeper planting. Subsoiling should always be done several months before planting to allow the soil to settle.

Slash, loblolly, shortleaf, and sand pine seedlings can be planted with root collars up to 3 inches below the soil surface, provided the planting hole is deep enough to avoid root deformation and the soil is well-drained. Improper planting resulting in j-rooting and L-rooting slows early seedling growth. In wet soils with a high water table, plant seedling root collars only 1 inch below the soil surface. Never plant seedlings with the roots exposed above the soil surface.

Continue or postpone planting?

Characteristic	Continue planting	Postpone planting
1. Seedling quality	Deterioration due to exposure under unfavorable weather conditions	Deterioration due to prolonged storage
2. Probability of acceptable survival	Dependent on local conditions	Decreases as the season progresses
3. Procurement of additional seedlings	Better early in the season	Becomes increasingly difficult as the season progresses
4. Soil moisture	Usually more favorable early in the season	Often soils dry out as the season progresses
5. Availability of planters	Good	Questionable

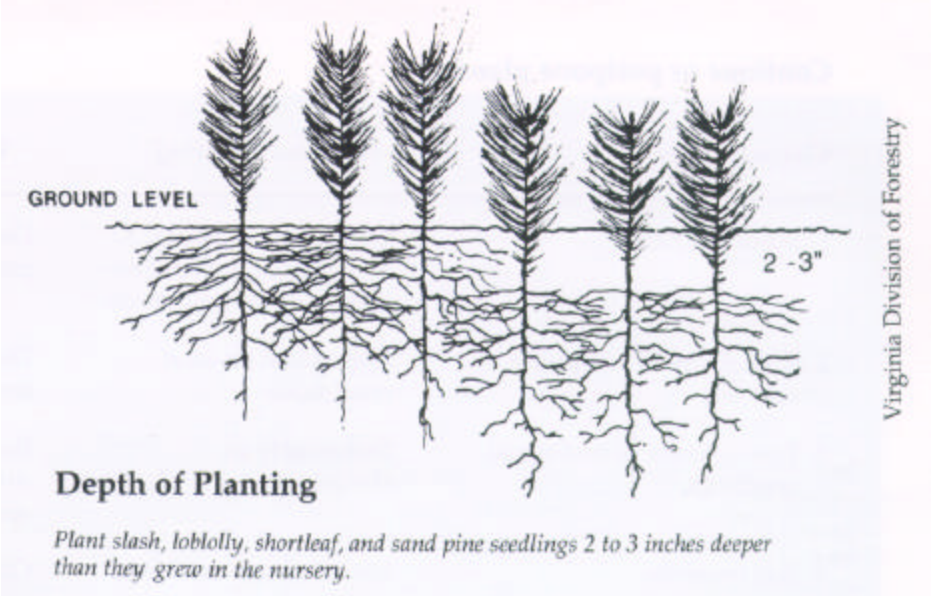
Hand vs. machine planting

Characteristic	Hand	Machine
Topography	No restrictions	10-percent slope or less
Erosion potential	None	Significant
Contour planting required	No	Yes
Rocky sites (large rocks)	Can modify spacing	Difficult to maneuver
Logging debris	No restrictions (large amounts on site reduce production)	Must be free of large logs/stumps
Degree of site preparation required	No restrictions	Must be free of large logs/stumps
Poorly drained soil	No restrictions	Difficult when wet
Average production	800-2,000/day (1 person)	7,000-11,000/day (2-person crew)
Probability of high planting quality with large seedlings (e.g., longleaf)	Low	High

Longleaf pine requires special care in planting and great attention to planting depth. Plant longleaf seedlings so the bud is not buried or the root collar exposed. The large tap root and lateral root system of high-quality longleaf seedlings requires larger and deeper planting holes than other pines. Hand planters should use the larger-type KBC dibble, rather than the narrow OST dibble. Machine planting is always preferred.

Regardless of the planting method, plant seedlings at the correct spacing and depth so that the roots are not deformed, and the soil is firmly packed around the roots to eliminate air pockets.

Have a written contract that details all planting specifications including transport and handling of seedlings, planting dates, spacing, and conditions when planting is to be suspended (site too wet or too dry, freezing weather, or summer-like conditions). The contract should provide for inspections during planting to ensure that quality standards are met before payment is made. This is especially important when planting with cost-share programs. Cost-share payments may be withheld if the quality of the work is low. Of course, top-quality planting is always in the best interest of both the landowner and the vendor.



Depth of Planting

Plant slash, loblolly, shortleaf, and sand pine seedlings 2 to 3 inches deeper than they grew in the nursery.

REMEMBER
Always supervise all steps o f the planting operation!

Seedling Care at the Planting Site

When there are no storage facilities at the planting site, take only as many seedlings as can be planted in a day. If time and logistics permit, arrange to have seedlings delivered twice a day. Load and transport packages carefully to avoid damage to seedlings.

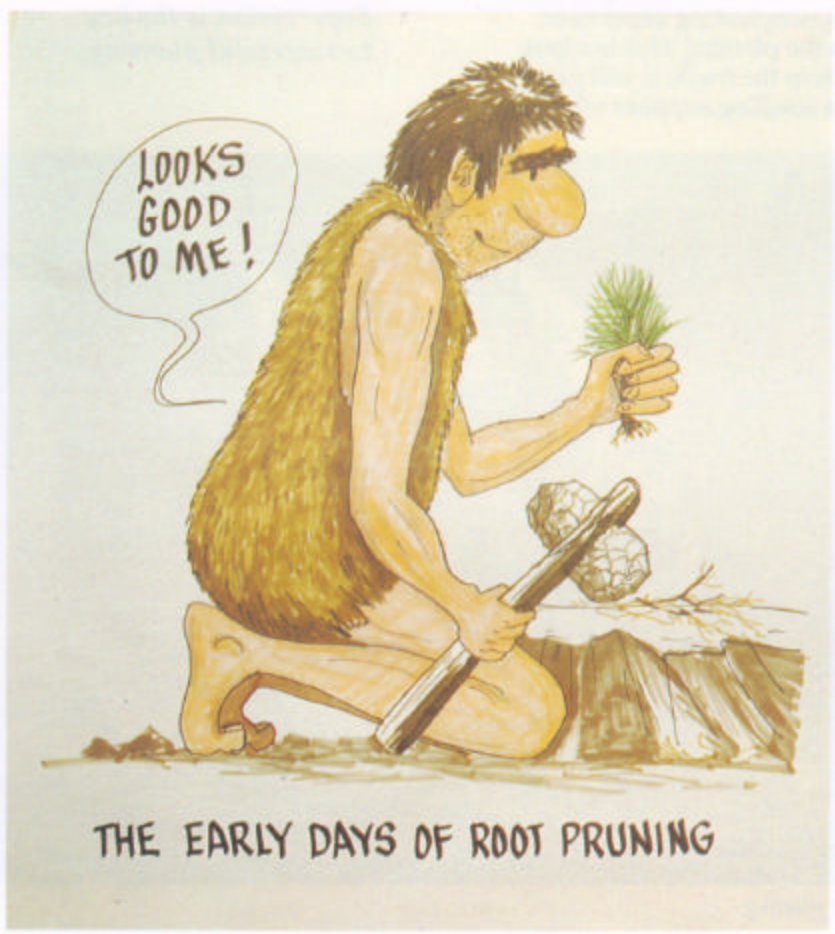
Seedling quality deteriorates quickly with careless field storage and handling. Always provide a shaded storage area. A tarp can be erected to shade the seedlings. Heat-reflective tarps are very effective. Be sure that there is ample ventilation to prevent heat buildup in the packages. Do not lay a tarp directly over the seedlings during the day. Be sure to leave plenty of air space between the tarp and the seedling packages and also between individual packages. Temperatures inside seedling packages can quickly exceed 50° F on sunny days, even when air temperatures are moderate. Temperatures exceeding 50° F will quickly reduce the quality of the seedlings.

Ideally seedlings not planted should be returned to cold storage. If this cannot be done, cover seedlings left overnight in the field with a tarp at sunset to protect against freezing. Repair any tears or holes to the packages with duct tape. Re-package the seedlings as necessary.

Check seedlings carefully.
Look for:

- Fermentation smell (smells like silage)
- Black color and/or mold on roots
- Bark "slips" on stems or roots
- Chlorotic, yellow needles
- Seedlings warm to touch

When giving seedlings to the planters, open and empty only one package at a time. Make sure that planters carry seedlings in bags or buckets. Never allow seedlings to be hand-carried with roots exposed while planting. Have water and clay or synthetic gel dips available to keep seedling roots moist. Do not leave seedling roots in water, clay slurry, or gel solution for more than 1 hour—repackage them in their original or in new packages.



Heeling-In—The practice of removing seedlings from their packages and planting them in shallow ditches is called "heeling-in." This was common in the Soil Bank era. **Currently, heeling-in is not recommended since many roots and mycorrhizae are lost in the process of digging the seedlings.** Careful storage in packages is more effective than "heeling-in." Mycorrhizae are beneficial associations between tree roots and soil fungi that increase the size and efficiency of the root system.

REMEMBER
Roots and mycorrhizae are essential for good survival and growth!

Root Pruning—Root pruning should never be done after the seedlings leave the nursery. The physical damage done to the seedlings and the additional exposure are both highly detrimental to survival and growth.

Frozen Seedlings

Seedlings frozen for more than 1 day should be discarded. Seedlings frozen for short periods (less than 1 day) can be thawed and safely planted. Let them completely thaw slowly before attempting to separate and plant. Always handle frozen seedlings very carefully as roots are very brittle. Freeze-damaged root systems will appear limp and discolored, and root tips will easily slough off in handling. Discard seedlings that appear to have suffered freeze damage. Longleaf pine seedlings are extremely vulnerable to cold injury. If longleaf seedlings have been frozen for even a short period, they should be discarded.

If there is some doubt about the condition of seedlings, it is safer to discard them rather than to plant dead or dying seedlings.

Do:
Examine stored seedlings carefully, looking for signs of freeze damage.

Do Not: Take the chance of planting dead seedlings.

Hand Planting

An experienced hand-planting crew can average 1,500 seedlings planted per person per day—inexperienced crews far less. Production ranges from 600 on very rough sites to 2,000 in open fields. It is essential, however, that seedlings be planted carefully—quality is more important than quantity.

Crews work most efficiently when the planters are aligned at a 45° angle to the direction of planting. The lead person establishes the line and sets the pace. The others in turn guide on this spacing and maintain the proper distance between rows. The fastest planters should always work at the leading end of the crew and be paid a little more per hour as an incentive.

Planting crew organization should be flexible and adapted to the size of area, terrain, distance from road and other factors. An efficient crew is 10 to 12 planters with a nonplanting supervisor. When the planting area is a long way from the truck, it will pay to have a seedling supplier who does nothing but keep the planters supplied with trees and drinking water.

Most planters use a dibble bar or hoedad, with a blade at least 4 inches wide and 10 inches long. Seedlings can be carried in a bucket, but a planting bag is more efficient. The planting bag is strapped around the planter's waist and holds several hundred seedlings. Seedlings are dipped in a synthetic gel or packed in the bags with wet moss. The bag protects seedlings from sun and wind. The planter removes one seedling at a time after the dibble has been used to open the planting slit. DO NOT allow planters to carry seedlings in the hand while planting as seedlings will rapidly dry out. Just a few minutes of exposure to wind and sun can kill the seedlings. Always provide planting bags or buckets and insist that seedlings be kept moist at all times.

REMEMBER
Supervision is the key to successful planting.


PHOTO: BARRY NEHS

Hand planting.

PHOTO: DAVID MOORHEAD

Dipping seedling roots in a gel solution restores lost moisture.

Have a supervisor at the site to ensure that planting proceeds smoothly and properly. The supervisor should watch for poor practices such as stripping-off roots to make planting large seedlings easier, slower planters discarding seedlings to catch up with the faster planters, shallow planting, loose packing of soil, and carrying seedlings in hand during planting.

Make frequent checks to ensure that correct spacing is maintained. Measure the distances of planted seedlings within and between rows. Proper packing is necessary to eliminate air pockets around the roots. Check by grasping several needles at the tip of the seedling between thumb and forefinger and gently try to pull the seedling from the soil. The needles should break if the seedling is firmly packed. A shovel can be used to dig around seedlings to check for J-rooting.

The planting supervisor is the key to good production. Supervisors are needed to maintain the quantity and quality of work. They must drop unwilling or incapable planters from the crew, place faster planters at the head of the planting line, and constantly check planting spacing. They should spot check the work of each planter about five times each day to verify the quality of their work. Look for:

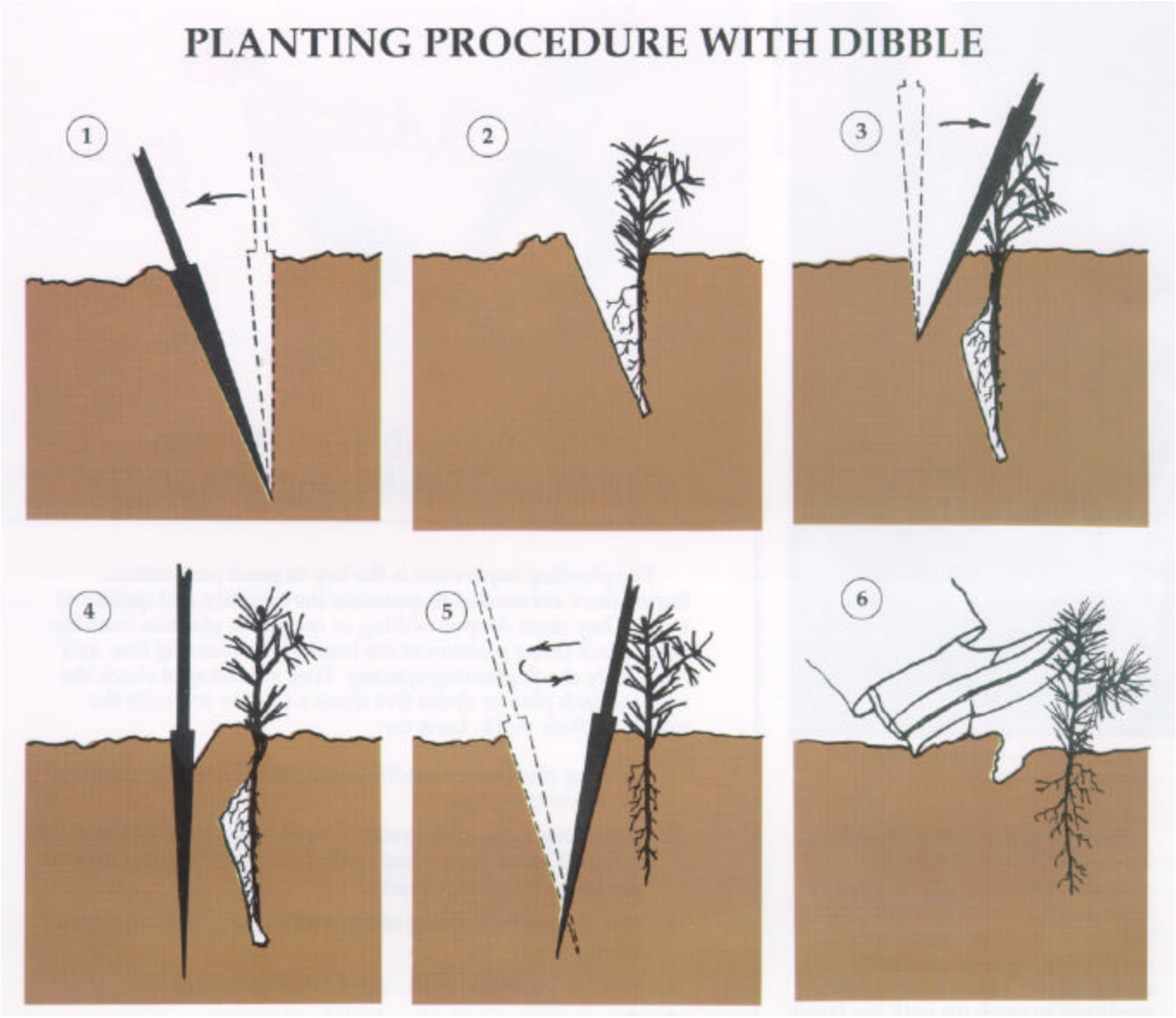
1. Tearing roots when seedlings are pulled from the package or the carrying bag.
2. Trimming roots with thumb or knife. This results in short or stripped roots. Root pruning should never be done after the seedlings leave the nursery.
3. Not closing bale or bag when seedling supplies are replenished.

4. Not having moss, mud, or gel in planting bags.
5. Carrying trees in the hand while planting.
6. Failing to open a hole the full length of the planting bar, resulting in U- or J-roots.

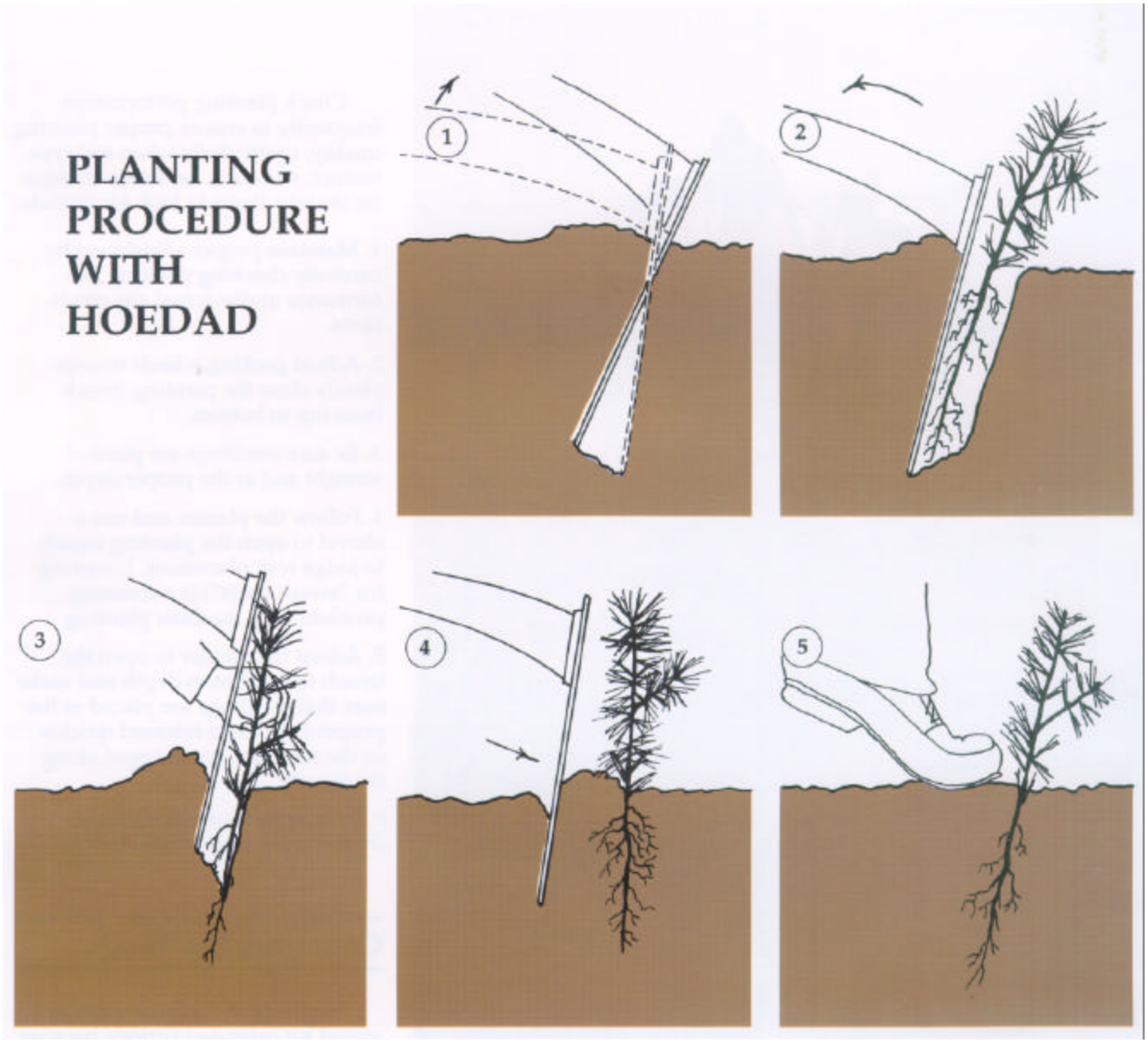
7. Failing to push the tree to the bottom of the hole and then pulling it up to the proper position, again resulting in U- or J-roots.

8. Failing to close the hole tightly.
9. Spacing too close. If planters are allowed to do a lot of talking, they tend to bunch up and plant seedlings too close together.
10. Discarding of seedlings by slow planters who wish to conceal their lack of production.

11. Planting under living trees that will not be removed or killed.
12. Planting seedlings without consideration of wildlings already on the ground.



1. Insert the dibble straight down into the soil to the full depth of the blade and pull back on the handle to open the planting hole. (DO NOT rock the dibble back and forth as this causes soil in the planting hole to be compacted, inhibiting root growth.)
2. Remove the dibble and push the seedling roots deep into the planting hole. Pull the seedling back up to the correct planting depth (the root collar should be 1 to 3 inches below the soil surface). Gently shake the seedling to allow the roots to straighten out. DO NOT twist or spin the seedling or leave the roots J-rooted.
3. Insert the dibble several inches in front of the seedling and push the blade halfway into the soil. Twist and push the handle forward to close the top of the slit to hold the seedling in place.
4. Push the dibble down to the full depth of the blade.
5. Pull back on the handle to close the bottom of the planting hole. Then push forward to close the top, eliminating air pockets around the root.
6. Remove the dibble and close and firm up the opening with your heel. BE CAREFUL to avoid damaging the seedling.



1. Strike blade almost vertically, full depth of the blade, into the soil. Pull up on the handle to break the soil loose at the bottom of the hole. Caution - Avoid raising the handle more than a few inches. The hole will fill with soil and the seedling will be shallow-rooted.

2. Slide hand down handle almost to the blade. Pull back and down on the handle to form a pocket on far side of the blade. With the other hand, immediately roll the seedling roots into the pocket to the full depth of the hole.

3. Hold seedling in place while sliding the hoedad blade out of the hole. Loose soil should fall into the hole holding seedling in place.

4. Pull blade completely out of the hole and push soil against planted tree with the tip of the blade.

5. Use foot to firm the soil against the seedling. Do not step on or bruise seedling with your foot.

PHOTO: BRUCE BALDWIN

Careful machine planting places seedlings at the correct depth and spacing.

Machine Planting

A well-trained and supervised planting crew and a machine that is correctly matched to the site, can plant 7,000 to 9,000 seedlings per day. The condition of the planting site is important in selecting the proper size of the machine. Old fields and cropland can be planted with light-duty planters pulled by wheeled tractors having 20 plus horsepower. Rough sites require heavy-duty planters pulled by large farm tractors or crawler tractors of 50 plus horsepower.

Seedlings are fed into the machines by two systems—a manual system in which each seedling is placed into the trench by hand, and an automated system in which seedlings are placed in mechanical "fingers" that position them in the planting trench.

When seedling packages must be carried on the tractor, protection from high temperature must be considered. Never place seedlings on top of the tractor engine, radiator, or near the exhaust pipe.

Check planting performance frequently to ensure proper planting quality, particularly when soil type, texture, moisture, or debris changes on the site. Items to look for include:

1. Maintain proper adjustment by carefully checking planting performance under actual site conditions.

2. Adjust packing wheels to completely close the planting trench from top to bottom.

3. Be sure seedlings are planted straight and at the proper depth.

4. Follow the planter and use a shovel to open the planting trench to judge root placement. L-rooting (or "swept roots") is a common problem with machine planting.

5. Adjust the planter to open the trench to maximum depth and make sure that seedlings are placed at the proper depth and released quickly so the roots are not dragged along the trench.

6. Be sure that the tractor is not dripping oil or hydraulic fluid.

Container Seedlings

Seedlings in containers can be stored for extended periods because their roots are protected. They must be protected from freezing and desiccation however. The limited soil volume of the container makes the seedlings very susceptible to desiccation in sunny and windy conditions. Store in partial to full shade and water frequently to maintain adequate moisture throughout storage and planting.

Container seedlings may be planted by machine or by hand. With either method, it is critical that the planting hole be deep enough so that the top of the root plug can be completely covered with soil. If the top of the root plug is not covered with soil, it will dry rapidly by a wicking action, and the seedling will die. Careful covering also reduces frost heaving of fall planted seedlings. Take special care when planting container longleaf pine seedlings. Plant too deep and the bud is covered, plant too shallow and the root plug is exposed, rapidly drying out the rooting medium. Planting depth is critical for longleaf pine-both container and bareroot. Longleaf pine is an exacting species!

Planting Conditions

Keep a close check on the site and environmental conditions at planting time. Planting on bright, sunny, windy days in dry soil can result in rapid seedling mortality. Dry soil is difficult to pack around the seedling roots and cannot supply needed moisture when seedlings need it the most. When soils are too wet, especially clay soils, machine planting can compact the soil, reducing both survival and growth.

Optimum planting weather is a temperature between 35° F to 60° F, a relative humidity greater than 40 percent, and a windspeed less than 10 mph. When air temperature is in the 70's or low 80's, humidity is less than 40 percent and windspeed is 10 mph or greater, delay planting until conditions improve. Do not plant in freezing weather or summer-like conditions. The North Carolina Forest Service has developed a system of weather classification for planting (see appendix).

Trouble shooting guide for machine planting

Observation	Possible causes
L- or U-Root	Insufficient weight or hydraulic pressure on frame or planting box Need hydraulic fluid Worn coulter (riding on hub) Gap between coulter and shoe too great (buildup of debris) Worn planting shoe or foot Soil too dry Planting seedling too deep in trench
Seedlings damaged by packing wheels	Packing wheel misaligned Packing wheels too close
Seedlings thrown out of ground or planted at angle	Angle of packing wheels too flat Releasing seedling too late Mud buildup on packing wheels
Seedlings not well packed	Not enough weight or pressure on packing wheel or packing coulter Hitch not adjusted correctly Packing wheels too far apart Soil too hard
Trash in holes	Need scalper or V-blade
Seedlings planted too shallow	Site-prepared soil not settled Releasing seedling too soon

Balmer and Williston 1974.

Evaluation of the Planting Job

In tree planting, the desired objective is a fully stocked stand of healthy trees in a "free-to-grow" condition. The plantation should be monitored to be sure that objective is met. The monitoring process begins shortly after the seedlings are planted and should continue through at least three growing seasons.

After planting, sites should be periodically revisited to check for such things as animal damage, frost heaving, and other unforeseen events that sometimes occur. If severe damage has occurred shortly after planting, there may be time to replant.

After a full growing season, plantations should be checked to determine stocking, survival, and release needs. Systematically spaced 1 / 100th-acre plots can be used to determine the number of live trees on the area as a whole, the areas needing replanting or release. The type of competing vegetation and its abundance and severity should be inventoried. Seedlings that are overtopped by competing woody vegetation are at risk of dying or having normal growth greatly reduced.

Note: Plantation evaluation forms and instructions are located in the appendix.

REMEMBER

All o f the investment in tree breeding, nursery culture, and careful handling can be lost if planting is done carelessly!

PHOTO: CLARK LANTZ

A successful plantation!